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SEG

Special Report

Geophysical Activity in 1983

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Geophysical Activity Committee

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Special Report
Geophysical Activity in 1983

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Report of the SEG Geophysical Activity Committee. Members of the Committee are Russell J. Senti, Chairman; Susan J. Allen, Lionel G. Cane, Charles Curtis, John T. Doherty, Harry R. Espey, Lin Evans, George D. Hair, Ronald R. Hartman, Richard Hopkins, William C. Kellogg, Fritz P. Kronberger, Gerald E. Montgomery, H. Roice Nelson, Jr., Paul L. Stoffa, Tommy A. Tillery, A. H. Watts, and Michael D. Watts.

Introduction

This report presents statistical data on worldwide geophysical activity in 1983. The data were gathered from survey questionnaires that were mailed to more than 500 companies, contractors, government agencies, and institutions throughout the free world. We have attempted to gather data from all users of geophysical techniques in the areas of petroleum, mining, geothermal, and groundwater exploration and from those who employ geophysical methods in engineering, oceanography, and research. Response to the survey was excellent, thanks to a computerized mailing list that was implemented at the SEG Business Office last year. There was an 8 percent increase in the response this year compared to last year.

Detailed information was gathered on airborne, drill hole, land, and marine geophysical surveys. Statistics were compiled on miles of coverage, number of stations, drill hole footage, time spent in crew-months or man-months, and acquisition costs. Data not supplied on the questionnaires by the respondent were estimated on the basis of massive statistical averaging for the area and techniques reported. This process is necessary to avoid distortion of individual statistical items.

This report, when compared to past annual reports, provides a basis for detecting and analyzing trends in technological developments and exploratory trends in geographical areas. Changes in these trends reflect the influence of factors, such as technological advances, inflation, government regulations, and exploration philosophy. Cost figures are also sensitive to many factors, such as operational environment, length and nature of the survey, type of instrumentation, etc. Unit costs reported by universities are substantially lower than those reported by industry due to the use of student labor and donated equipment. These costs, however, must be averaged with industry costs to accommodate the format of the report. Therefore, when examining unit cost figures, one must be cognizant of the broad spectrum of activity embraced by individual categories.

Table 1. Total worldwide expenditures in US$ (thousands) by survey type and objective.

Type	Petroleum[1]	Minerals	Engineering	Geothermal	Groundwater	Oceanography	Research	Total
Land	2,189,685	21,523	3,500	6,732	1,311		2,734	2,225,485
Marine	1,279,105	175	22,969			5,868	5,766	1,313,883
Airborne	24,185	25,975	70	1,105		108	329	51,772
Drill hole	3,796	770	1,104	155	227		115	6,167
Total	3,496,771	48,443	27,643	7,992	1,538	5,976	8,944	3,597,307

[1]Includes processing and interpretation costs for land and marine. See text for details.

Note: All tables in this report where figures are expressed in thousands of dollars have been rounded off as individual items; but the computer keeps track of all the truncated numbers and then the sums of the individual items are rounded off. As a result of this procedure, the rounded individual items may not add up precisely to the rounded sums.

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1983 Highlights

Worldwide expenditures on geophysical exploration in 1983 were down 14 percent from last year but were up 20 percent from 1980 and up 74 percent from 1979 (see Table 1). The decrease came primarily in the petroleum area which was down 14 percent from 1982. Expenditures reported for mining and engineering increased 24 and 14 percent, respectively, while those reported for geothermal, oceanography, groundwater and research declined some 28–44 percent.

Distribution of expenditures by geographic area and survey objective is shown in Table 2. Over 49 percent of all expenditures for geophysical work was spent in the United States. All areas showed a decrease in expenditures over 1982 except Mexico and Canada. Mexico had an increase in expenditures of 323 percent, but we believe most of that is due to an under-reported condition in 1982. Canada showed almost a 19 percent gain over last year with most of that in land activity. The area with the largest decrease was Australia/New Zealand which just two years earlier had seen the largest increase. Australia/New Zealand had a 39 percent decrease in activity while the Middle East, South America, Europe, the United States, Africa and the Far East declined 25, 24, 16, 15, 4, and 2 percent, respectively. (It should be noted that if you are comparing the Middle East figures between 1982 and this year you must reduce the amount of expenditures reported in 1982 by $70,000,000. A data entry error was just discovered this year.)

The cost of processing and interpretation are included in Figures 1 and 2 and the petroleum column of Tables 1 and 2. All other tables show acquisition costs only. Again, this year, two additional columns (one for processing costs and one for interpretation costs) were added to our questionnaires. It was hoped we could obtain more detailed data for these costs. Unfortunately, again, less than 10 percent of the companies and contractors responded. I did use this small bit

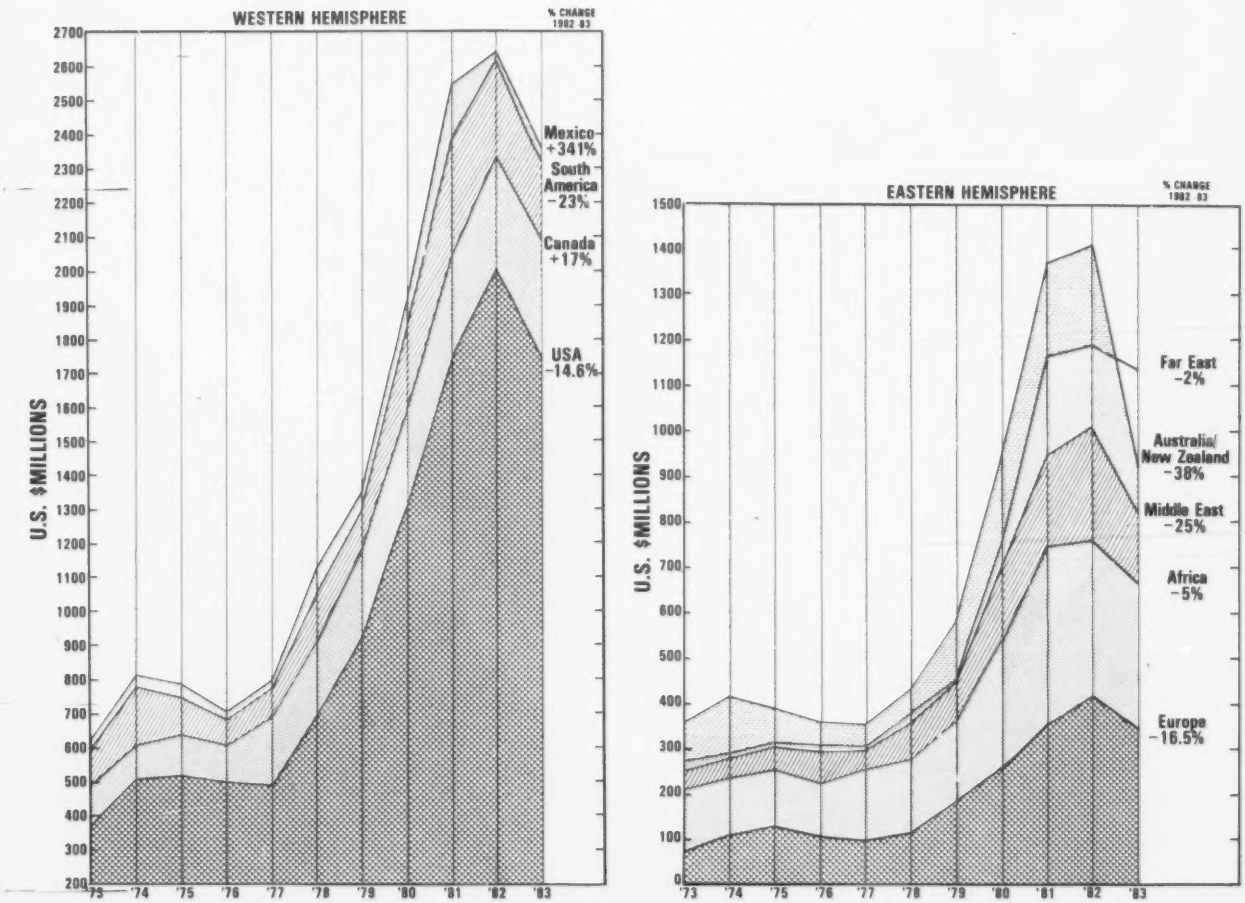

FIG. 1 Total expenditures on petroleum exploration, 1973-1983.

Table 2. Total worldwide expenditures in US$ (thousands) by area and survey objective.

Area	Petroleum[1]	Minerals	Engineering	Geothermal	Groundwater	Oceanography	Research	Total
International	12,037					1,615	3,867	17,519
U.S.A.	1,736,493	4,847	16,624	1,295	525	1,052	3,256	1,764,092
Canada	348,697	17,724	215		91	400	293	367,420
Mexico	33,792	1,276		329				35,397
South America	233,715	445	85			375		234,620
Europe	344,053	5,285	5,185	145	182	1,551	468	356,869
Africa	321,870	11,870	2,748		283	375	360	337,506
Middle East	156,817	165	1,551			500		159,033
Far East	213,703	4,299	1,235	6,223	457	108	100	226,125
Australia/ New Zealand	95,594	2,532					600	98,726
Total	3,496,771	48,443	27,643	7,992	1,538	5,976	8,944	3,597,307

[1]Includes processing and interpretation costs.

of data, combined with my own best estimates to arrive at the following figures: U.S. $765 per line-mile was used for the Western Hemisphere and U.S. $650 per line-mile was used for the Eastern Hemisphere. The higher cost in the Western Hemisphere is based on the premise that, in general, a more rigorous processing and interpretation treatment is required because of the subtle structural and stratigraphic prospects that may be economically viable objectives in much of the Western Hemisphere but are not usually primary targets in much of the Eastern Hemisphere.

Petroleum exploration

Over 97 percent of all geophysical dollars were spent on petroleum exploration (U.S. $3.5 billion) in 1983. Expenditures in the U.S. declined 14.6 percent while Mexico showed a strong increase of 341 percent. (Again, we believe Mexico to be considerably under-reported in 1982.) Canada experienced a 17 percent increase, while all the remaining areas declined some 2–38 percent. Geophysical activity in the Western Hemisphere declined over 11 percent and the Eastern Hemisphere declined nearly 20 percent.

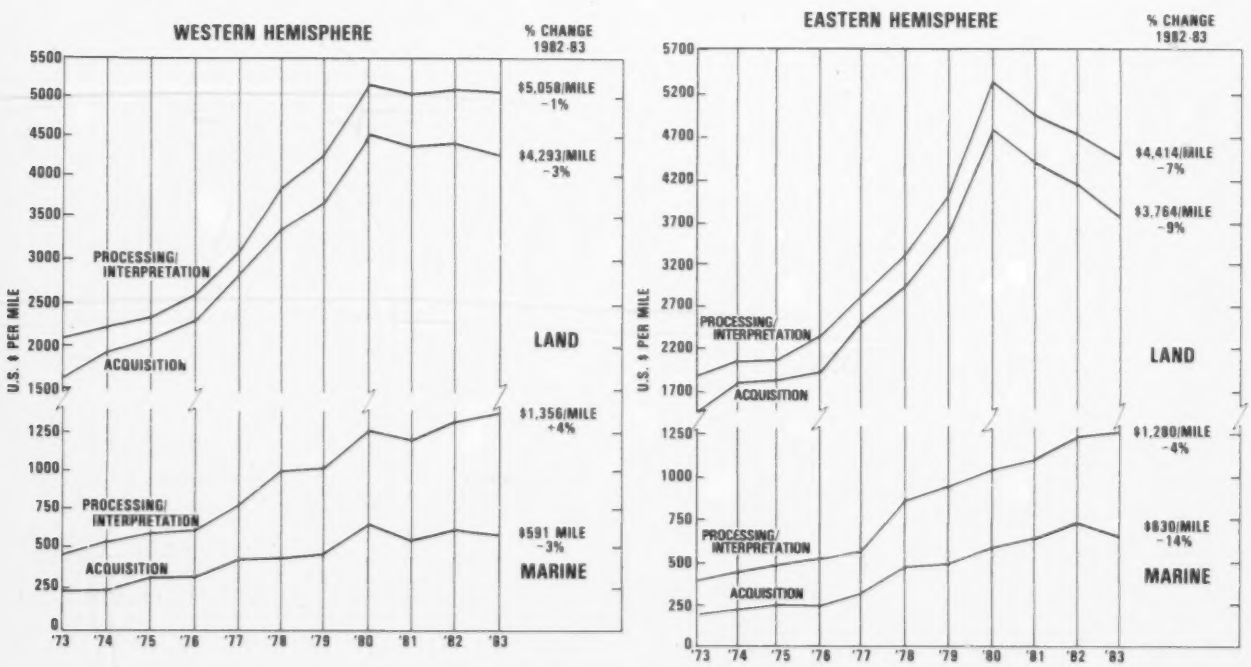

FIG. 2 Average cost per mile for petroleum surveys, 1973-1983.

Table 3. Worldwide petroleum land seismic activity.

Area	Acquisition costs - US$	Line-miles	Crew-months*		Crew-months total*	Average miles/month	Average cost/month	Average cost/mile
			Company	Contract				
U.S.A.	929,212,217	188,457	488.2	3,886.0	4,374.2	43	212,430	4,930
Canada	193,620,297	73,662	65.5	515.3	580.8	126	333,368	2,628
Mexico	21,585,000	5,167		170.0	170.0	30	126,970	4,177
South America	137,367,000	31,324		483.1	483.1	64	284,344	4,385
Europe	102,113,767	25,865	1.0	534.1	535.1	48	190,831	3,947
Africa	187,714,777	47,162	28.0	547.0	575.0	82	326,460	3,980
Middle East	123,373,607	28,001		346.6	346.6	80	355,953	4,406
Far East	105,176,036	27,644	3.2	412.3	415.5	66	253,131	3,804
Australia/ New Zealand	44,731,004	19,622		163.2	163.2	120	274,087	2,279
Total	1,844,893,705	446,904	585.9	7,057.6	7,643.5	58	241,367	4,128

*Total includes government and university activity.

Table 4. Worldwide petroleum land seismic line-miles by energy source.

Area	Dynamite	Compressed air	Gas exploder	Weight drop	Solid chemical	Vibrator	Other	Total line-miles
U.S.A.	76,471	12,219	1,384	2,958		95,360	65	188,457
Canada	48,813	2,878		1,065		20,906		73,662
Mexico	2,286					2,881		5,167
South America	11,602				438	19,284		31,324
Europe	9,708	1,065		30		12,727	2,335	25,865
Africa	15,061	414		6,300		24,838	549	47,162
Middle East	3,388	1,510		4,860		17,561	682	28,001
Far East	19,748	5,632			75	2,189		27,644
Australia/ New Zealand	7,219				81	12,322		19,622
Total	194,296	23,718	1,384	15,213	594	208,068	3,631	446,904

Table 5. Worldwide petroleum marine seismic activity.

Area	Acquisition costs - US$	Line-miles	Crew-months*		Crew-months total*	Average miles/month	Average cost/month	Average cost/mile
			Company	Contract				
International	11,037,625	15,527		21.8	21.8	712	506,313	710
U.S.A.	274,887,500	469,227	99.4	469.7	569.1	824	483,021	585
Canada	51,476,236	60,599		77.4	77.4	782	665,067	849
Mexico	1,650,000	3,300		3.2	3.2	1,031	515,625	500
South America	23,369,400	61,623		46.9	46.9	1,313	498,281	379
Europe	111,024,512	169,865	2.2	206.8	209.0	812	531,217	653
Africa	48,455,438	63,177	6.9	77.6	84.5	747	573,437	766
Middle East	6,076,000	12,799		12.3	12.3	1,040	493,983	474
Far East	38,195,000	79,699	.1	84.3	84.4	944	452,547	479
Australia/ New Zealand	19,293,000	28,465		36.7	36.7	775	525,694	677
Total	585,464,711	964,281	108.6	1,036.7	1,145.3	841	511,188	607

*Total includes government and university activity.

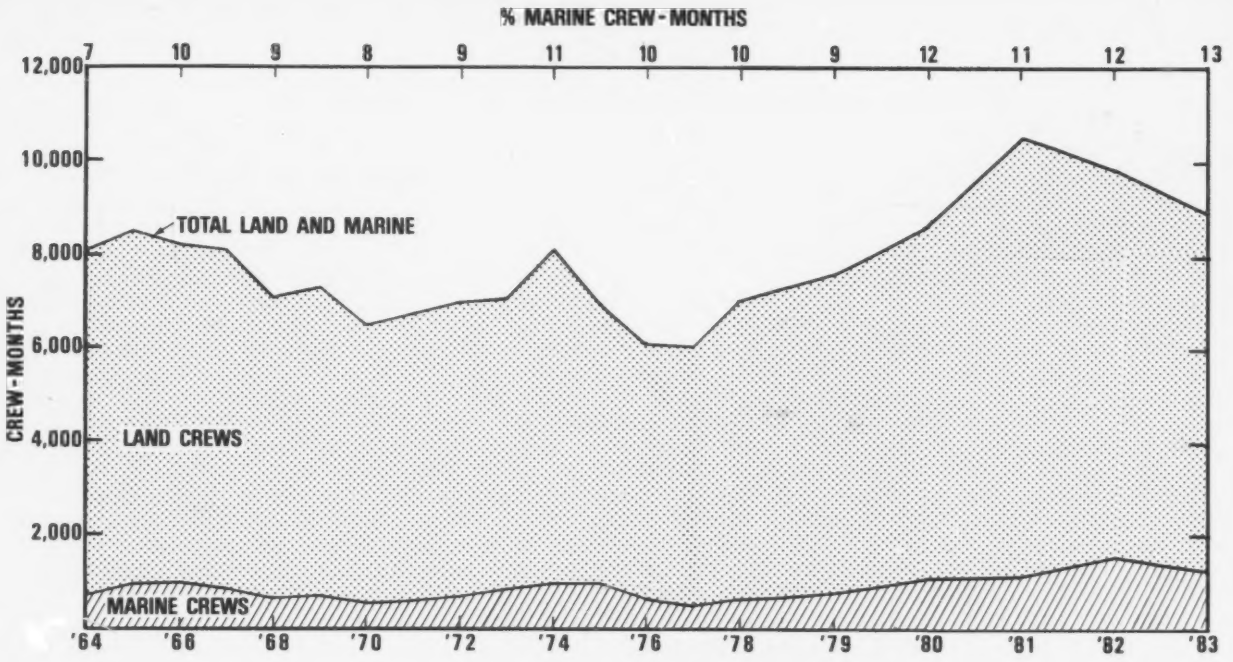

FIG. 3 Worldwide seismic activity in crew-months, 1964-1983.

A 10-year history of geophysical activity in both the Western and Eastern Hemispheres is shown in Figure 1.

Seismic surveys

The seismic method accounted for 94 percent of all expenditures in geophysical activity. This statistic, plus the strong tendency for wildcatting to follow and parallel seismic activity, has caused those interested in forecasts of petroleum exploration to regard seismic activity as a barometer for exploration. A 10-year history of the cost of petroleum seismic surveys in both the Eastern and Western Hemispheres is shown in Figure 2. In the Western Hemisphere, the acquisition cost per mile of land seismic surveys dropped 2.6 percent, while marine costs declined 3 percent. In the Eastern Hemisphere, acquisition costs per mile for land seismic decreased 9 percent, while marine costs fell over 14 percent.

The total number of miles of seismic data recorded worldwide was down 13 percent on land and down over 12 percent in marine work (see Tables 3 and 5). While we had

Table 6. Worldwide petroleum marine seismic line-miles by energy source.

Area	Compressed air	Gas exploder	Implosive	Total line-miles
International	15,527			15,527
U.S.A.	423,024	36,875	9,328	469,227
Canada	60,599			60,599
Mexico	3,300			3,300
South America	61,623			61,623
Europe	161,472		8,393	169,865
Africa	48,276		14,901	63,177
Middle East	12,799			12,799
Far East	79,699			79,699
Australia/ New Zealand	28,465			28,465
Total	894,784	36,875	32,622	964,281

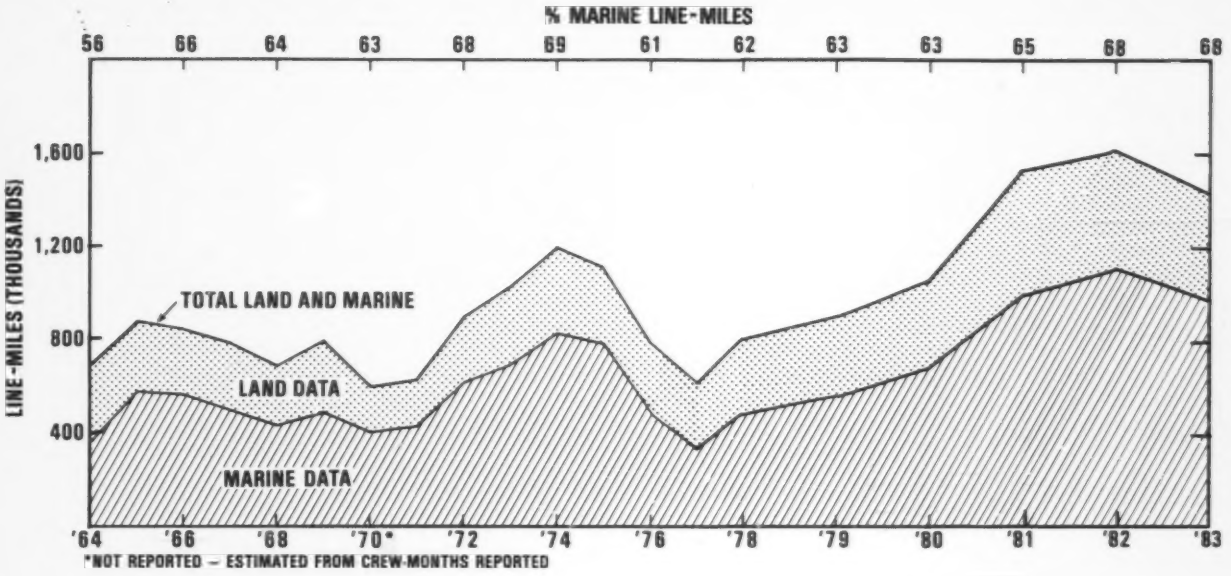
% MARINE LINE-MILES
56 66 64 63 68 69 61 62 63 63 65 68 68
LINE-MILES (THOUSANDS)
1,600
1,200
800
400
TOTAL LAND AND MARINE
LAND DATA
MARINE DATA
'64 '66 '68 '70* '72 '74 '76 '78 '79 '80 '81 '82 '83
*NOT REPORTED – ESTIMATED FROM CREW-MONTHS REPORTED

FIG. 4 Worldwide seismic activity in line-miles, 1964-1983.

a reduction in the total number of miles of seismic worldwide, the Far East, Canada, and Mexico all had increases in the number of miles recorded in their areas. Group seismic surveys and speculation surveys continue to be popular. Operators, reacting to the high costs of gathering proprietary data, choose to sacrifice the competitive advantages for the low cost of nonproprietary data.

The most popular land seismic energy source worldwide in 1983 was the Vibroseis® source. This is the first time that dynamite has been replaced as the most popular land source worldwide. Together these two energy sources account for 90 percent of all seismic land work. In marine work the air gun (compressed air) and gas exploder sources accounted for 96.6 percent of the total line-miles (see Table 6).

A more comprehensive breakdown of statistical data on petroleum surveys, sorted by geographic area, can be seen in Table 7. Table 8 shows petroleum seismic activity by states in the U.S. Some of the states showing large gains over last year were Arkansas, Colorado, Florida, Indiana, Kentucky, Ohio, South Dakota, Washington, and Wyoming. The states of Alaska, Arizona, Montana, North Dakota, and Oregon showed a significant reduction in activity in 1983. Tables 9 and 10 show petroleum seismic activity in Canada and Mexico, respectively.

A 51-year history of seismic exploration in the U.S. is shown in Figure 5. This information is compiled by the SEG Business Office. Data for this graph are gathered monthly by telephone.

Gravity and magnetic surveys

Table 11 shows worldwide expenditures for gravity and magnetic surveys. The 1983 data show an 11 percent increase in the use of these tools compared to last year. The petroleum objective contributed to most of this increase with a 34 percent rise in activity, all of which was in Africa. Therefore, it should not be surprising that the Eastern Hemisphere showed a 51 percent increase in the use of these surveys while the Western Hemisphere declined 11 percent.

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Airborne surveys

Statistical data on airborne surveys are shown in Tables 12, 13a and 13b. Expenditures for airborne surveys increased 4 percent with all of the increase in Africa for mineral exploration. Magnetic surveys continue to be the most popular, with input and combined EM/Mag. surveys ranking second and third, respectively.

Land mining

Tables 14a and 14b report expenditures and methods utilized for land mining in the Western and Eastern Hemispheres. Reported usage of geophysical exploration for minerals using land methods was up from 1982. The largest increase occurred in Canada.

Engineering, geothermal, groundwater, oceanography, and research

Table 15 reports engineering/groundwater activity. Table 16 contains worldwide geothermal work. Average unit costs for all survey objectives, types, and methods can be found in Table 17. Groundwater activity is markedly lower than last year but the increase in engineering helps offset that and gives us a combined increase of 9 percent in these two areas (see Table 15). Geothermal activity is down 27 percent which can be attributed to the reduction in airborne work. Research and oceanography are both down this year. For geographic distribution of these expenditures, refer to Table 2.

Table 7. Worldwide average unit costs for petroleum surveys.

Area, survey type, and method	Total* crew-months or (man-months)	Miles or (footage) or [stations]	Acquisition costs – US$	Average miles or (footage) or [stations]/ crew-month or (man-month)	Average cost/ crew-month or (man-month)	Average cost/ mile or (foot) or [station]
International						
Marine						
Seismic (P-wave)						
Compressed air	21.8	15,527	11,037,625	712	506,313	710
Airborne						
Gravity	1.5	[52,000]	1,000,000	[34,666]	666,666	[19]
U.S.A.						
Land						
Seismic (P-wave)						
Dynamite	2,148.0	76,486	456,119,195	35	212,341	5,963
Dynamite	3.2	[861]	141,500	[264]	43,538	[164]
Compressed air	165.5	12,220	44,588,748	73	269,402	3,648
Gas exploder	21.0	1,384	4,667,000	65	222,238	3,372
Weight drop	51.6	2,958	8,865,656	57	171,715	2,997
Vibratory	1,970.2	94,969	410,310,924	48	208,253	4,320
Other	2.1	65	191,048	30	90,975	2,939
Seismic (S-wave)						
Vibratory	15.6	416	4,328,146	26	277,090	10,386
Gravity	165.5	43,090	4,170,453	260	25,199	96
Gravity	33.5	[43,629]	921,498	[1,300]	27,466	[21]
Gravity	(2.2)	[1,800]	5,400	[800]	(2,400)	[3]
Magnetic	.5	60	7,500	120	15,000	125
Electromagnetic						
Frequency domain	4.8	53	217,459	11	45,303	4,072
Frequency domain	2.0	[65]	140,000	[32]	70,000	[2,153]
Induced polarization	20.7	231	963,758	11	46,468	4,157
Magnetotelluric	3.8	135	258,000	35	67,362	1,911
Magnetotelluric	31.7	[2,859]	8,806,493	[90]	277,369	[3,080]
Other	1.2	[800]	106,000	[666]	88,333	[132]
Marine						
Seismic (P-wave)						
Compressed air	517.7	423,025	251,600,700	817	485,940	594
Gas exploder	36.6	36,875	17,470,800	1,007	477,344	473
Implosive	14.9	9,328	5,816,000	626	390,335	623
Gravity	13.2	34,768	2,703,400	2,624	204,030	77
Magnetic	.3	448	11,500	1,210	31,081	25
Airborne						
Gravity	4.0	[120,000]	3,000,000	[30,000]	750,000	[25]
Magnetic	49.1	261,600	6,618,530	5,327	134,796	25
Remote sensing						
Side-scan radar	3.0	72,000	1,050,000	24,000	350,000	14
Drill hole						
Other	2.5	**	286,000	**	114,400	**

*Total includes government and university activity.
**Incomplete data.

Table 7. Worldwide average unit costs for petroleum surveys (cont.).

Area, survey type, and method	Total* crew-months or (man-months)	Miles or (footage) or [stations]	Acquisition costs - US$	Average miles or (footage) or [stations]/ crew-month or (man-month)	Average cost/ crew-month or (man-month)	Average cost/ mile or (foot) or [station]
Canada						
Land						
Seismic (P-wave)	361.9	43,143	130,413,994	119	360,299	3,022
Dynamite	41.5	2,878	7,764,000	69	187,084	2,697
Compressed air	13.7	1,065	2,944,000	77	214,420	2,764
Weight drop	144.0	20,906	43,498,303	145	302,071	2,080
Vibratory						
Seismic (refraction)	20.0	5,670	9,000,000	283	450,000	1,587
Dynamite	.5	6	10,500	12	21,000	1,750
Gravity	5.0	[3,500]	140,000	[700]	28,000	[40]
Gravity						
Electromagnetic	.4	6	17,203	16	43,007	2,646
Frequency domain						
Induced polarization	3.0	30	60,000	10	20,000	2,000
Magnetotelluric	.6	[30]	60,000	[45]	90,909	[2,000]
Other	1.0	[600]	30,000	[600]	30,000	[50]
Marine						
Seismic (P-wave)						
Compressed air	77.4	60,599	51,476,236	782	665,067	849
Gravity	8.0	8,000	240,000	1,000	30,000	30
Airborne						
Magnetic	.2	1,045	33,425	4,180	133,700	31
Drill hole						
Radiometric						
Neutron activation	2.0	(30,000)	300,000	(15,000)	150,000	(10)
Mexico						
Land						
Seismic (P-wave)						
Dynamite	108.0	2,286	14,324,000	21	132,629	6,265
Vibratory	62.0	2,881	7,261,000	46	117,112	2,520
Gravity	96.0	9,600	1,680,000	100	17,500	175
Magnetotelluric	24.0	[720]	2,400,000	[30]	100,000	[3,333]
Marine						
Seismic (P-wave)						
Compressed air	3.2	3,300	1,650,000	1,031	515,625	500
South America						
Land						
Seismic (P-wave)						
Dynamite	185.1	11,602	52,733,000	62	284,889	4,545
Solid chemical	6.0	438	5,600,000	73	933,333	12,785
Vibratory	292.0	19,284	79,034,000	66	270,664	4,098
Resistivity	2.0	24	31,440	12	15,720	1,310
Magnetotelluric	2.0	70	140,000	35	70,000	2,000
Marine						
Seismic (P-wave)						
Compressed air	46.9	61,623	23,369,400	1,313	498,281	379
Airborne						
Magnetic	11.7	42,623	1,203,900	3,642	102,897	28
Remote sensing						
Side-scan radar	2.0	48,000	500,000	24,000	250,000	10

*Total includes government and university activity.

Table 7. Worldwide average unit costs for petroleum surveys (cont.).

Area, survey type, and method	Total* crew-months or (man-months)	Miles or (footage) or [stations]	Acquisition costs – US$	Average miles or (footage) or [stations]/ crew-month or (man-month)	Average cost/ crew-month or (man-month)	Average cost/ mile or (foot) or [station]
Europe						
Land						
Seismic (P-wave)						
Dynamite	276.8	9,710	47,279,287	35	170,806	4,869
Compressed air	1.0	1,066	1,570,000	1,005	1,481,132	1,472
Weight drop	2.0	30	270,000	15	135,000	8,970
Vibratory	238.3	12,730	48,898,480	53	205,197	3,841
Other	17.1	2,335	4,096,000	136	239,532	1,753
Gravity	18.5	11,413	874,575	616	47,274	76
Induced polarization	8.0	120	300,000	15	37,500	2,500
Magnetotelluric	1.0	35	70,000	35	70,000	2,000
Marine						
Seismic (P-wave)						
Compressed air	195.7	161,473	105,759,087	825	540,386	654
Implosive	13.4	8,394	5,265,425	626	392,942	627
Gravity	2.7	3,297	82,850	1,186	29,802	25
Magnetic	1.3	1,557	39,200	1,197	30,153	25
Airborne						
Magnetic	6.0	30,703	614,415	5,075	101,556	20
Drill hole						
Sonic/velocity logging	(57.0)	(854,500)	1,709,000	(14,991)	(29,982)	(2)
Africa						
Land						
Seismic (P-wave)						
Dynamite	205.9	15,061	68,396,130	73	332,100	4,541
Compressed air	7.0	414	1,684,800	59	240,685	4,062
Weight drop	63.0	6,300	17,995,000	100	285,634	2,856
Vibratory	292.2	24,838	98,538,847	85	337,230	3,967
Other	6.9	549	1,100,000	79	159,420	2,003
Gravity	27.0	12,252	1,955,375	453	72,421	159
Gravity	2.0	[2,300]	800,000	[1,150]	400,000	[347]
Resistivity	.5	6	7,860	12	15,720	1,310
Marine						
Seismic (P-wave)						
Compressed air	59.9	47,688	37,333,338	795	622,637	782
Implosive	23.7	14,904	9,307,100	627	391,548	624
Seismic (refraction)						
Compressed air	1.0	593	1,815,000	565	1,728,571	3,059
Gravity	5.9	6,514	165,000	1,091	27,638	25
Magnetic	4.6	5,417	135,000	1,177	29,347	24
Airborne						
Gravity	3.3	[129,000]	3,500,000	[39,090]	,060,606	[27]
Magnetic	26.2	225,800	5,959,166	8,601	227,015	26
Radiometric						
Gamma ray	.5	3,500	76,500	7,000	153,000	21
Drill hole						
Sonic/velocity logging	(46.0)	(690,000)	1,380,000	(15,000)	(30,000)	(2)

*Total includes government and university activity.

Table 7. Worldwide average unit costs for petroleum surveys (cont.).

Area, survey type, and method	Total* crew-months or (man-months)	Miles or (footage) or [stations]	Acquisition costs – US$	Average miles or (footage) or [stations]/ crew-month or (man-month)	Average cost/ crew-month or (man-month)	Average cost/ mile or (foot) or [station]
Middle East						
Land						
Seismic (P-wave)						
Dynamite	58.7	3,388	21,711,881	57	369,878	6,408
Compressed air	22.0	1,510	5,290,400	68	240,472	3,503
Weight drop	40.0	4,860	14,721,466	121	368,036	3,029
Vibratory	222.8	17,561	80,449,860	78	361,085	4,581
Other	3.1	682	1,200,000	220	387,096	1,759
Gravity	23.0	14,495	543,000	630	23,608	37
Magnetic	5.0	970	68,000	194	13,600	70
Marine						
Seismic (P-wave)						
Compressed air	12.3	12,799	6,076,000	1,040	493,983	474
Gravity	4.0	7,625	116,000	1,906	29,000	15
Drill hole						
Sonic/velocity logging	(.7)	(10,500)	21,000	(15,000)	(30,000)	(2)
Other	1.0	**	100,000	**	100,000	**
Far East						
Land						
Seismic (P-wave)						
Dynamite	361.3	19,748	81,678,527	54	226,068	4,136
Compressed air	31.2	5,632	17,329,400	180	555,429	3,076
Solid chemical	1.0	75	255,000	75	255,000	3,400
Vibratory	22.0	2,189	5,913,109	99	268,777	2,701
Magnetotelluric	2.0	70	140,000	35	70,000	2,000
Marine						
Seismic (P-wave)						
Compressed air	84.3	79,639	38,010,000	944	450,782	477
Seismic (refraction)						
Compressed air	.1	60	185,000	600	1,850,000	3,083
Gravity	2.5	3,053	75,000	1,221	30,000	24
Magnetic	.05	59	1,500	1,194	30,000	25
Airborne						
Magnetic	2.6	20,550	343,100	7,754	129,471	16
Australia/New Zealand						
Land						
Seismic (P-wave)						
Dynamite	66.2	7,219	14,403,111	108	217,405	1,995
Solid chemical	1.0	81	187,200	81	187,200	2,311
Vibratory	96.0	12,322	30,140,693	128	313,965	2,446
Gravity	.5	[500]	27,000	[1,000]	54,000	[54]
Marine						
Seismic (P-wave)						
Compressed air	36.7	28,465	19,293,000	775	525,694	677
Airborne						
Magnetic	5.0	51,700	286,000	10,340	57,200	5

*Total includes government and university activity.
**Incomplete data.

Table 8. U.S.A. petroleum seismic activity by area.

State	Acquisition costs – US$	Line-miles	Crew-months		Total months*
			Company	Contract	
Land					
Undesignated	34,117,800	8,399	.0	146.7	146.7
Alaska	58,867,921	6,907	.0	57.6	57.6
Alabama	26,137,445	4,033	10.7	94.5	105.2
Arkansas	28,396,262	4,646	21.0	95.7	116.7
Arizona	868,614	151	.0	4.0	4.0
California	35,509,591	7,393	23.0	163.2	186.2
Colorado	32,721,471	7,138	6.9	169.1	176.0
Florida	6,720,718	1,679	3.3	33.5	36.8
Georgia	127,006	64	.0	1.5	1.5
Idaho	10,589,633	929	4.2	27.0	31.2
Illinois	1,313,859	414	3.0	8.0	11.0
Indiana	433,500	102	.0	3.4	3.4
Kansas	13,002,230	3,472	5.7	69.3	75.0
Kentucky	3,802,032	844	.0	23.7	23.7
Louisiana	102,068,673	17,976	76.3	346.9	423.2
Massachusetts	485,000	326	.3	.0	.3
Maryland	291,772	46	.0	2.0	2.0
Michigan	26,484,028	5,757	18.5	141.1	159.6
Missouri	105,000	27	.0	1.5	1.5
Mississippi	25,443,044	4,361	23.7	100.4	124.1
Montana	33,569,272	6,765	4.5	151.9	156.4
North Dakota	21,956,294	5,388	16.4	97.4	113.8
Nebraska	2,727,695	722	.0	14.4	14.4
New Mexico	22,754,693	6,208	8.3	107.3	115.6
Nevada	10,950,332	1,946	12.0	27.4	39.4
New York	1,221,300	284	.0	7.2	7.2
Ohio	2,241,949	729	.0	15.4	15.4
Oklahoma	60,147,456	13,992	38.8	276.9	315.7
Oregon	2,532,415	445	2.5	10.6	13.1
Pennsylvania	4,546,025	1,124	.0	26.5	26.5
South Carolina	1,400,000	280	.0	7.0	7.0
South Dakota	2,754,000	612	.0	13.6	13.6
Tennessee	3,142,008	466	.0	16.5	16.5
Texas	240,786,477	55,231	157.6	1,195.4	1,353.0
Utah	29,160,165	4,162	.5	110.8	111.3
Virginia	999,557	408	.0	8.5	8.5
Washington	4,310,907	813	4.5	17.0	21.5
West Virginia	2,066,012	684	.0	16.7	16.7
Wyoming	74,460,061	13,534	46.5	276.4	322.9
Total Land	929,212,217	188,457	488.2	3,886.0	4,374.2
Marine					
Undesignated	40,926,000	58,426	.0	68.9	68.9
East Coast	2,508,000	6,931	8.0	3.0	11.0
Gulf Coast	161,125,900	295,254	69.8	307.1	376.9
Off Alaska	38,483,800	55,854	6.3	48.0	54.3
West Coast	31,843,800	52,762	15.3	42.7	58.0
Total Marine	274,887,500	469,227	99.4	469.7	569.1
Total U.S.A.	1,204,099,717	657,684	587.6	4,355.7	4,943.3

*Total includes government and university activity.

Table 9. Canada petroleum seismic activity by area.

Province	Acquisition costs - US$	Line-miles	Crew-months		Total months
			Company	Contract	
Land					
Undesignated	15,695,000	6,748	.0	91.2	91.2
Alberta	127,801,172	52,161	46.5	327.0	373.5
British Columbia	8,116,859	1,218	1.5	17.8	19.3
Manitoba	1,980,238	1,513	.0	6.3	6.3
New Brunswick	1,711,200	249	6.0	.0	6.0
Nova Scotia	248,500	33	1.0	.0	1.0
Northwest Territories	12,854,535	1,326	.0	16.8	16.8
Ontario	1,200,000	350	.0	8.0	8.0
Quebec	25,000	10	.0	1.0	1.0
Saskatchewan	23,672,214	10,025	10.5	46.6	57.1
Yukon Territory	315,579	29	.0	.6	.6
Total Land	193,620,297	73,662	65.5	515.3	580.8
Marine					
Undesignated	35,181,000	37,134	.0	41.6	41.6
East Coast	13,495,000	18,982	.0	23.5	23.5
Northwest Territories	2,320,236	3,583	.0	11.3	11.3
West Coast	480,000	900	.0	1.0	1.0
Total Marine	51,476,236	60,599	.0	77.4	77.4
Total Canada	245,096,533	134,261	65.5	592.7	658.2

Table 10. Petroleum seismic activity in Mexico.

Area	Acquisition costs - US$	Line-miles	Crew-months		Total months
			Company	Contract	
Land					
Various	21,585,000	5,167	.0	170.0	170.0
Marine					
Various	1,650,000	3,300	.0	3.2	3.2
Total Mexico	23,235,000	8,467	.0	173.2	173.2

Table 11. Total worldwide expenditures on gravity and magnetic surveys in US$ (thousands).

Area	Petroleum	Minerals	Engineering	Geothermal	Groundwater	Oceanography	Research	Total
International	1,000					500	2,168	3,668
U.S.A.	17,438	1,012	86	94	5		255	18,892
Canada	423	1,481	25				10	1,940
Mexico	1,680	1,037		15				2,732
South America	1,203							1,203
Europe	1,611	190					8	1,809
Africa	12,514	4,775	25		6		120	17,442
Middle East	727							727
Far East	419	2,569		1,290		108	100	4,486
Australia/ New Zealand	313	1,126					150	1,589
Total	37,331	12,192	137	1,399	11	608	2,811	54,492

Table 12. Total worldwide expenditures on airborne surveys in US$ (thousands).

Area	Petroleum	Minerals	Engineering	Geothermal	Oceanography	Research	Total
International	1,000						1,000
U.S.A.	10,668	1,788	69	255		79	12,861
Canada	33	7,968					8,002
Mexico		1,000					1,000
South America	1,703	123					1,827
Europe	614	1,041				250	1,905
Africa	9,535	10,053					19,589
Far East	343	2,371		850	108		3,672
Australia/ New Zealand	286	1,627					1,913
Total	24,185	25,975	69	1,105	108	329	51,772

Table 13A. Western Hemisphere airborne activity in US$ (thousands).

	International		USA		Canada		Mexico		South America	
Survey method	Line-miles	Cost	Line-miles	Cost	Line-miles	Cost	Line-miles	Cost	Line-miles	Cost
Gravity	[52,000]	1,000	[120,000]	3,000						
Magnetic			313,980	7,356	33,254	1,059	30,625	1,000	42,623	1,203
Electromagnetic (time domain)			2,100	255						
Electromagnetic (frequency domain)			4,800	528						
Combined EM/Mag.			2,098	199	46,333	3,710			1,243	123
Input			7,674	473	60,848	3,232				
Remote Sensing (side-scan radar)			72,000	1,050					48,000	500
Total	[52,000]	1,000	402,652 [120,000]	12,861	140,435	8,002	30,625	1,000	91,866	1,827

[No. of stations]

Table 13B. Eastern Hemisphere airborne activity in US$ (thousands).

	Europe		Africa		Far East		Australia/New Zealand	
Survey method	Line-miles	Cost	Line-miles	Cost	Line-miles	Cost	Line-miles	Cost
Gravity			[129,000]	3,500				
Magnetic	30,703	614	352,363	10,273	200,700	3,672	184,650	1,315
Combined EM/Mag.	2,354	233					1,041	103
Input	9,840	667	35,500	2,130			8,250	495
Radioactivity	3,500	140	145,619	3,685				
Remote Sensing (multispectral scanning)	7,383	250						
Total	53,780	1,905	533,482 [129,000]	19,589	200,700	3,672	193,941	1,913

[No. of stations]

Table 14A. Western Hemisphere land mining activity in US$ (thousands).

Survey method	USA		Canada		Mexico		South America	
	Line-miles	Cost	Line-miles	Cost	Line-miles	Cost	Line-miles	Cost
Seismic reflection (P-wave)	30	150	3,131	5,107				
Seismic reflection (S-wave)			6	40				
Seismic refraction	61	296					20	16
Gravity	509	274	269	283				
Magnetic	282	79	1,305	172	336	37		
Resistivity	20	21	160	100	20	6		
Self-potential	(300,000)	160					(127,000)	265
Electromagnetic (time domain)	196	301	420	315	93	100	3	7
Electromagnetic (freq. domain)	546	620	1,021	468	10	5		
Combined EM/Mag.	348	239	2,743	801	44	22		
VLF	61	48	358	44				
Induced polarization	368	618	1,385	1,618	167	105		
Earth current	25	25						
Radiometric (gamma ray)	4	6	17,030	445			135	33
Other	[2,056]	136	[900]	54				
Total	2,450	2,978	27,828	9,450	670	276	158	322
(Logged footage)	(300,000)		[900]				(127,000)	
[No. of stations]	[2,056]							

Table 14B. Eastern Hemisphere land mining activity in US$ (thousands).

Survey method	Europe		Africa		Middle East		Far East		Australia/New Zealand	
	Line-miles	Cost	Line-miles	Cost	Line-miles	Cost	Line-miles	Cost	Line-miles	Cost
Seismic reflection (P-wave)	359	3,544					66	423	9	129
Seismic refraction							4	3		
Gravity	[8,870]	190	1,070	182			[12,317]	195	175	97
Magnetic			2,454	274			16	2		
Resistivity	200	95	225	85			[28,106]	702		
Self-potential			25	5			14	5		
Electromagnetic (time domain)	135	101	121	104	135	101	28	17	[1,335]	396
Electromagnetic (freq. domain)			423	55			2	2	36	73
Combined EM/Mag.			455	301						
VLF	140	15					28	3		
Induced polarization	62	64	774	256			16	574	167	210
Radiometric (gamma ray)			1,797	146			[57,400]			
Magnetotelluric	20	80			15	60				
Total	916	4,090	7,344	1,410	150	161	158	1,928	387	905
[No. of stations]	[8,870]						[97,823]		[1,335]	

Table 15. Worldwide groundwater and engineering activity.

Survey method	Area			Time*		Cost
	Line-miles	Stations	Footage	Crew-months	Man-months	US$ (thousands)
Seismic reflection (P-wave)	36,992	440		107.8	.5	20,537.0
Seismic reflection (S-wave)	13			6.0		60.0
Seismic refraction	8,451			40.9	48.7	5,183.7
Gravity		4,076		3.4		49.5
Magnetic	117		4,091	7.1	.5	99.1
Resistivity	1,043	5,987	33,726	110.6	13.4	1,225.7
Self-potential	5		23,225	.5	2.2	76.2
Sonic/velocity logging			442,127	3.0	84.8	1,057.7
Electromagnetic (time domain)	184	1,320		6.2	6.2	98.0
Electromagnetic (freq. domain)	18	22		8.0	.2	26.0
Combined EM/Mag.	702	3,600		.7	1.5	85.0
VLF	1	10,400			2.4	56.0
Induced polarization	2			.5		25.0
Radiometric (gamma ray)			41,175		5.5	83.6
Temperature gradient			4,600		4.6	23.0
Magnetotelluric		125		1.0		12.0
Other	536		14,250	3.5	20.1	484.3
Total	48,064	25,970	563,194	299.2	190.6	29,181.8

*Includes government and university activity.

Table 16. Worldwide geothermal activity.

Survey method	Area			Time*		Cost
	Line-miles	Stations	Footage	Crew-months	Man-months	US$ (thousands)
Seismic reflection(P-wave)	85			2.0		378.0
Seismic refraction				15.0		140.0
Gravity	11,062	2,300		13.7		549.7
Magnetic	25,000			2.0		850.0
Resistivity	236	1,875		86.5		1,232.3
Electromagnetic (time domain)	2,100	200		2.6		355.0
Electromagnetic (frequency domain)	25	250		4.9		163.7
Temperature gradient			90,000		13.0	155.0
Magnetotelluric	15	1,259		48.6		4,168.6
Total	38,523	5,884	90,000	175.3	13.0	7,992.3

*Total includes government and university activity.

Table 17. Worldwide average unit costs by survey objective, type, and method.

Area, survey type, and method	Total* crew-months or (man-months)	Miles or (footage) or [stations]	Acquisition costs – US$	Average miles or (footage) or [stations]/ crew-month or (man-month)	Average cost/ crew-month or (man-month)	Average cost/ mile or (foot) or [station]
Petroleum						
Land						
Seismic (P-wave)						
Dynamite	3,772.1	188,644	887,059,125	50	235,162	4,702
Dynamite	3.2	[861]	141,500	[264]	43,538	[164]
Compresed air	268.2	23,721	78,227,348	88	291,599	3,297
Gas exploder	21.0	1,384	4,667,000	65	222,238	3,372
Weight drop	170.3	15,213	44,796,122	89	262,949	2,944
Solid chemical	8.0	594	6,042,200	74	755,275	10,172
Vibratory	3,339.5	207,681	804,045,216	62	240,764	3,871
Other	29.2	3,631	6,587,048	124	225,583	1,813
Seismic (S-wave)						
Vibratory	15.6	416	4,328,146	26	277,090	10,386
Seismic (refraction)						
Dynamite	20.0	5,670	9,000,000	283	450,000	1,587
Gravity	330.5	90,856	9,233,903	274	27,939	101
Gravity	41.0	[49,929]	1,888,498	[1,216]	46,004	[37]
Gravity	(2.2)	[1,800]	5,400	[800]	(2,400)	[3]
Magnetic	5.5	1,030	75,500	187	13,727	73
Resistivity	2.5	30	39,300	12	15,720	1,310
Electromagnetic						
Frequency domain	5.2	59	234,662	11	45,127	3,917
Frequency domain	2.0	[65]	140,000	[32]	70,000	[2,153]
Induced polarization	31.7	381	1,323,758	12	41,706	3,467
Magnetotelluric	8.8	310	608,000	35	68,856	1,961
Magnetotelluric	56.4	[3,609]	11,266,493	[63]	199,725	[3,121]
Other	2.2	[1,400]	136,000	[636]	61,818	[97]
Marine						
Seismic (P-wave)						
Compressed air	1,056.0	894,140	545,605,386	846	516,647	610
Gas exploder	36.6	36,875	17,470,800	1,007	477,344	473
Implosive	52.0	32,627	20,388,525	626	391,559	624
Seismic (refraction)						
Compressed air	1.1	653	2,000,000	568	1,739,130	3,061
Gravity	36.5	63,259	3,382,250	1,733	92,664	53
Magnetic	6.3	7,482	187,200	1,183	29,620	25

*Total includes government and university activity.

Table 17. Worldwide average unit costs by survey objective, type, and method (cont.).

Area, survey type, and method	Total* crew-months or (man-months)	Miles or (footage) or [stations]	Acquisition costs – US$	Average miles or (footage) or [stations]/ crew-month or (man-month)	Average cost/ crew-month or (man-month)	Average cost/ mile or (foot) or [station]
Petroleum (cont.)						
Airborne						
Gravity	8.8	[301,000]	7,500,000	[34,204]	852,272	[24]
Magnetic	101.0	634,022	15,058,536	6,277	149,094	23
Radioactivity	.5	3,500	76,500	7,000	153,000	21
Remote sensing						
Side-scan radar	5.0	120,000	1,550,000	24,000	310,000	12
Drill hole						
Sonic/velocity logging	(103.7)	(1,555,000)	3,110,000	(14,995)	(29,990)	(2)
Radiometric						
Neutron activation	2.0	(30,000)	300,000	(15,000)	150,000	(10)
Other	3.5	**	386,000	**	110,286	**
Minerals						
Land						
Seismic (P-wave)						
Dynamite	28.7	3,405	8,368,224	118	291,575	2,457
Vibratory	1.5	40	236,000	26	157,333	5,900
Other	3.0	150	750,000	50	250,000	5,000
Seismic (S-wave)						
Dynamite	2.0	6	40,000	3	20,000	6,451
Seismic (refraction)						
Dynamite	3.0	61	296,765	20	98,921	4,865
Weight drop	2.4	24	19,200	10	8,000	800
Gravity	37.1	2,136	751,400	57	20,231	351
Gravity	17.5	[25,001]	465,741	[1,424]	26,537	[18]
Gravity	(1.0)	[175]	4,000	[175]	(4,000)	[22]
Magnetic	83.0	4,381	538,913	52	6,492	122
Magnetic	2.0	[9,000]	25,000	[4,500]	12,500	[2]
Magnetic	(4.0)	15	4,000	(3)	(1,000)	266
Resistivity	25.4	627	308,000	24	12,102	490
Resistivity	35.0	[28,106]	702,650	[803]	20,075	[25]
Self-potential	3.0	56	20,650	18	6,792	366
Self-potential	69.0	(427,000)	415,000	(6,188)	6,014	(1)
Electromagnetic						
Time domain	36.5	1,035	797,050	28	21,807	769
Time domain	16.5	[2,090]	647,500	[126]	39,242	[309]
Electromagnetic						
Frequency domain	57.5	2,040	1,222,626	35	21,233	599
Combined EM/Mag.	79.6	3,590	1,363,890	45	17,134	379
VLF	13.5	589	79,179	43	5,852	134
VLF	2.3	[11,000]	32,000	[4,721]	13,733	[2]
Induced polarization	167.4	2,945	2,793,625	17	16,680	948
Induced polarization	46.0	[65,462]	654,620	[1,423]	14,230	[10]
Earth current	(1.0)	25	25,000	(25)	(25,000)	1,000
Radiometric						
Gamma ray	31.5	18,946	624,571	600	19,802	32
Gamma ray	(30.0)	22	7,000	(1)	(233)	318
Magnetotelluric	3.5	35	140,000	10	40,000	4,000
Other	3.3	170	30,758	50	9,100	180
Other	3.6	[2,500]	160,000	[694]	44,444	[64]

*Total includes government and university activity.
**Incomplete data.

Table 17. Worldwide average unit costs by survey objective, type, and method (cont.).

Area, survey type, and method	Total* crew-months or (man-months)	Miles or (footage) or [stations]	Acquisition costs – US$	Average miles or (footage) or [stations]/ crew-month or (man-month)	Average cost/ crew-month or (man-month)	Average cost/ mile or (foot) or [station]
Minerals (cont.)						
Marine						
Seismic (P-wave)						
Compressed air	1.5	100	75,000	66	50,000	750
Other	1.0	600	100,000	600	100,000	166
Airborne						
Magnetic	78.6	505,547	10,399,225	6,428	132,238	20
Electromagnetic						
Frequency domain	4.0	4,800	528,000	1,200	132,000	110
Combined EM/Mag.	33.5	52,369	4,300,756	1,560	128,151	82
Input	25.5	122,112	6,997,900	4,781	273,997	57
Radioactivity	31.1	145,621	3,749,210	4,682	120,553	25
Drill hole						
Magnetic	.5	(4,500)	4,500	(9,000)	9,000	(1)
Resistivity	.2	(11,100)	9,990	(44,400)	39,960	(1)
Self-potential	8.0	(54,000)	38,000	(6,750)	4,750	(1)
Sonic/velocity logging	(19.9)	(74,100)	238,200	(3,723)	(11,969)	(3)
Electromagnetic						
Time domain	(10.0)	(65,000)	65,000	(6,500)	(6,500)	(1)
Induced polarization	5.0	(98,200)	178,650	(19,640)	35,730	(1)
Induced polarization	(4.0)	(30,000)	35,000	(7,500)	(8,750)	(1)
Radiometric						
Gamma ray	7.4	(145,000)	57,000	(19,594)	7,702	(1)
Gamma ray	(20.7)	(151,859)	138,315	(7,336)	(6,681)	(1)
Temperature gradient	(1.0)	(10,000)	6,000	(10,000)	(6,000)	(1)
Engineering						
Land						
Seismic (P-wave)						
Compressed air	4.0	595	900,000	148	225,000	1,512
Electrical	.5	372	120,000	744	240,000	322
Weight drop	3.2	33	66,000	10	20,370	2,000
Vibratory	.3	1	40,000	6	133,333	22,222
Seismic (S-wave)						
Weight drop	6.0	13	60,000	2	10,000	4,615
Seismic (refraction)						
Dynamite	10.3	152	110,000	14	10,679	723
Dynamite	(35.7)	147	545,045	(4)	(15,267)	3,700
Compressed air	1.7	354	307,000	201	174,431	867
Electrical	.2	15	27,000	62	112,500	1,800
Gas exploder	1.6	340	296,000	202	176,190	870
Weight drop	7.8	58	121,600	7	15,490	2,089
Weight drop	(4.5)	15	24,025	(3)	(5,257)	1,591
Solid chemical	(.3)	1	2,500	(3)	(8,333)	2,500
Other	1.7	1	54,000	1	30,857	49,090
Gravity	3.7	[4,076]	49,500	[1,101]	13,378	[12]
Magnetic	6.3	87	87,650	13	13,803	1,007
Resistivity	9.2	295	94,950	32	10,287	321
Resistivity	15.5	[1,568]	162,500	[101]	10,483	[103]
Resistivity	(9.5)	16	40,300	(1)	(4,242)	2,472
Resistivity	(.5)	[100]	4,000	[200]	(8,000)	[40]
Self-potential	.5	5	32,220	10	64,440	6,317

*Total includes government and university activity.

Table 17. Worldwide average unit costs by survey objective, type, and method (cont.).

Area, survey type, and method	Total* crew-months or (man-months)	Miles or (footage) or [stations]	Acquisition costs – US$	Average miles or (footage) or [stations]/ crew-month or (man-month)	Average cost/ crew-month or (man-month)	Average cost/ mile or (foot) or [station]
Engineering (cont.)						
Land						
Electromagnetic						
Time domain	.5	25	2,000	50	4,000	80
Time domain	2.0	[20]	3,000	[10]	1,500	[150]
Time domain	(5.7)	106	54,000	(18)	(9,473)	507
Electromagnetic						
Frequency domain	4.0	3	7,000	1	1,750	2,333
Frequency domain	3.0	[22]	4,000	[7]	1,333	[181]
Frequency domain	(.2)	1	2,500	(4)	(10,000)	2,500
Combined EM/Mag.	(1.5)	[3,600]	11,500	[2,400]	(7,666)	[3]
VLF	(2.1)	[10,400]	52,000	[4,952]	(24,761)	[5]
Induced polarization	.5	2	25,000	4	50,000	12,500
Magnetotelluric	1.0	[125]	12,000	[125]	12,000	[96]
Other	(16.4)	36	183,017	(2)	(11,125)	5,027
Marine						
Seismic (P-wave)						
Compressed air	8.0	1,420	5,700,000	177	712,500	4,014
Electrical	77.0	32,610	10,665,000	423	138,506	327
Electrical	(.5)	15	27,000	(30)	(54,000)	1,800
Gas exploder	10.7	1,950	2,975,000	182	278,037	1,525
Seismic (refraction)						
Compressed air	7.3	2,759	1,413,000	376	193,032	512
Electrical	2.9	1,436	407,000	485	137,500	283
Gas exploder	7.9	3,129	1,532,610	395	193,511	489
Other	1.9	500	250,000	263	131,578	500
Airborne						
Combined EM/Mag.	.6	700	69,510	1,044	103,746	99
Drill hole						
Sonic/velocity logging	(84.8)	(427,127)	1,027,700	(5,036)	(12,119)	(2)
Radiometric						
Gamma ray	(1.5)	(5,288)	18,600	(3,525)	(12,400)	(3)
Temperature gradient	(4.6)	(4,600)	23,000	(1,000)	(5,000)	(5)
Other	(3.7)	(6,650)	34,800	(1,797)	(9,405)	(5)
Geothermal						
Land						
Seismic (P-wave)						
Vibratory	1.0	60	253,000	60	253,000	4,216
Other	1.0	25	125,000	25	125,000	5,000
Gravity	6.0	11,062	440,000	1,843	73,333	39
Gravity	7.7	[2,300]	109,700	[296]	14,154	[47]
Resistivity	9.0	236	172,310	26	19,145	730
Resistivity	77.5	[1,875]	1,060,000	[24]	13,677	[565]
Electromagnetic						
Time domain	2.0	[200]	100,000	[100]	50,000	[500]
Electromagnetic						
Frequency domain	1.9	25	63,770	13	33,563	2,550
Frequency domain	3.0	[250]	100,000	[83]	33,333	[400]
Magnetotelluric	.5	15	15,000	30	30,000	1,000
Magnetotelluric	48.2	[1,259]	4,153,603	[26]	86,085	[3,299]
Airborne						
Magnetic	2.0	25,000	850,000	12,500	425,000	34
Electromagnetic						
Time domain	.6	2,100	255,000	3,500	425,000	121
Drill hole						
Temperature gradient	(13.0)	(90,000)	155,000	(6,923)	(11,923)	(1)

*Total includes government and university activity.

Table 17. Worldwide average unit costs by survey objective, type, and method (cont.).

Area, survey type, and method	Total* crew-months or (man-months)	Miles or (footage) or [stations]	Acquisition costs – US$	Average miles or (footage) or [stations]/ crew-month or (man-month)	Average cost/ crew-month or (man-month)	Average cost/ mile or (foot) or [station]
Groundwater						
Land						
Seismic (P-wave)						
Weight drop	4.4	[440]	44,000	[100]	10,000	[100]
Seismic (refraction)						
Dynamite	3.0	34	96,000	11	32,000	2,823
Weight drop	(8.5)	19	248,000	(2)	(29,176)	13,052
Magnetic	.8	31	6,500	37	7,831	206
Resistivity	48.2	683	225,600	14	4,671	329
Resistivity	35.3	[4,319]	626,150	[122]	17,737	[144]
Resistivity	(1.4)	51	5,700	(36)	(4,071)	111
Electromagnetic						
Time domain	2.7	51	28,000	18	10,218	549
Time domain	1.0	[1,300]	6,000	[1,300]	6,000	[4]
Time domain	(.5)	2	5,000	(4)	(10,000)	2,500
Electromagnetic						
Frequency domain	1.0	14	12,500	14	12,500	880
Combined EM/Mag.	.1	2	4,000	12	25,000	2,000
VLF	(.3)	1	4,000	(3)	(13,333)	4,000
Drill hole						
Magnetic	(.5)	(4,091)	5,000	(8,182)	(10,000)	(1)
Resistivity	2.5	(10,500)	22,500	(4,200)	9,000	(2)
Resistivity	(2.2)	(23,226)	44,000	(10,557)	(20,000)	(1)
Self-potential	(2.2)	(23,225)	44,000	(10,556)	(20,000)	(1)
Sonic/velocity logging	3.0	(15,000)	30,000	(5,000)	10,000	(2)
Radiometric						
Gamma ray	(4.0)	(35,887)	65,000	(8,971)	(16,250)	(1)
Other	1.6	(7,600)	16,500	(4,750)	10,312	(2)
Oceanography						
Marine						
Seismic (P-wave)						
Compressed air	21.4	6,985	548,000	325	25,523	78
Electrical	12.9	41,784	2,958,500	3,234	228,986	70
Implosive	7.5	9,375	1,406,250	1,250	187,500	150
Other	1.2	4,627	206,000	3,702	164,800	44
Magnetic	2.5	16,800	500,000	6,720	200,000	29
Other	7.0	15,000	250,000	2,142	35,714	16
Airborne						
Magnetic	.7	18,000	108,000	25,714	154,285	6
Research						
Land						
Seismic (P-wave)						
Dynamite	1.0	[400]	6,000	[400]	6,000	[15]
Compressed air	1.0	[1,000]	40,000	[1,000]	40,000	[40]
Weight drop	.1	6	30,000	60	30,000	5,000
Vibratory	6.0	215	1,154,000	35	192,333	5,367
Passive monitoring	1.0	[15]	15,000	[15]	15,000	[1,000]
Other	4.0	35	80,000	8	20,000	2,285
Seismic (S-wave)						
Weight drop	.5	3	2,000	6	4,000	666
Seismic (refraction)						
Dynamite	3.0	1,625	210,000	541	70,000	129

*Total includes government and university activity.

Table 17. Worldwide average unit costs by survey objective, type, and method (cont.).

Area, survey type, and method	Total* crew-months or (man-months)	Miles or (footage) or [stations]	Acquisition costs – US$	Average miles or (footage) or [stations]/ crew-month or (man-month)	Average cost/ crew-month or (man-month)	Average cost/ mile or (foot) or [station]
Research (cont.)						
Land						
Seismic (refraction)						
Dynamite	(2.5)	20	10,000	(8)	(4,000)	500
Compressed air	.5	.3	15,000	1	30,000	50,000
Weight drop	.5	.3	15,000	1	30,000	50,000
Passive monitoring	2.5	260	51,000	104	20,400	196
Other	2.5	40	23,500	16	9,400	587
Gravity	4.2	2,535	66,000	593	15,456	26
Gravity	29.0	[13,194]	261,000	[454]	9,000	[19]
Gravity	(24.0)	[3,880]	77,150	[161]	(3,214)	[19]
Magnetic	1.1	51	10,100	46	9,181	198
Resistivity	5.0	473	65,100	94	13,020	137
Resistivity	(8.0)	7	109,000	(1)	(13,625)	15,571
Resistivity	(2.5)	[392]	6,500	[156]	(2,600)	[16]
Self-potential	.2	.4	10,000	2	40,000	20,000
VLF	1.0	50	10,000	50	10,000	200
Induced polarization	7.1	57	270,000	8	38,028	4,695
Magnetotelluric	2.5	25	50,000	10	20,000	2,000
Magnetotelluric	5.1	[67]	137,800	[13]	27,019	[2,056]
Other	5.0	[100]	10,000	[20]	2,000	[100]
Marine						
Seismic (P-wave)						
Compressed air	12.4	25,707	2,708,087	2,063	217,342	105
Electrical	3.0	2,200	350,000	733	116,666	159
Seismic (refraction)						
Dynamite	(1.5)	250	180,000	(166)	(120,000)	720
Compressed air	.4	540	210,000	1,200	466,666	388
Gravity	8.9	28,730	674,000	3,228	75,730	23
Magnetic	10.6	50,484	1,644,000	4,762	155,094	32
Airborne						
Magnetic	1.0	6,330	79,715	5,915	74,500	12
Remote sensing						
Multispectral scanning	1.0	7,383	250,000	7,383	250,000	33
Drill hole						
Sonic/velocity logging	(1.0)	(300)	15,000	(300)	(15,000)	(50)
Electromagnetic						
Time domain	(1.0)	(300)	18,000	(300)	(18,000)	(60)
Combined EM/Mag.	(.5)	(300)	2,000	(600)	(4,000)	(6)
Other	.1	(800)	80,000	(8,000)	80,000	(100)

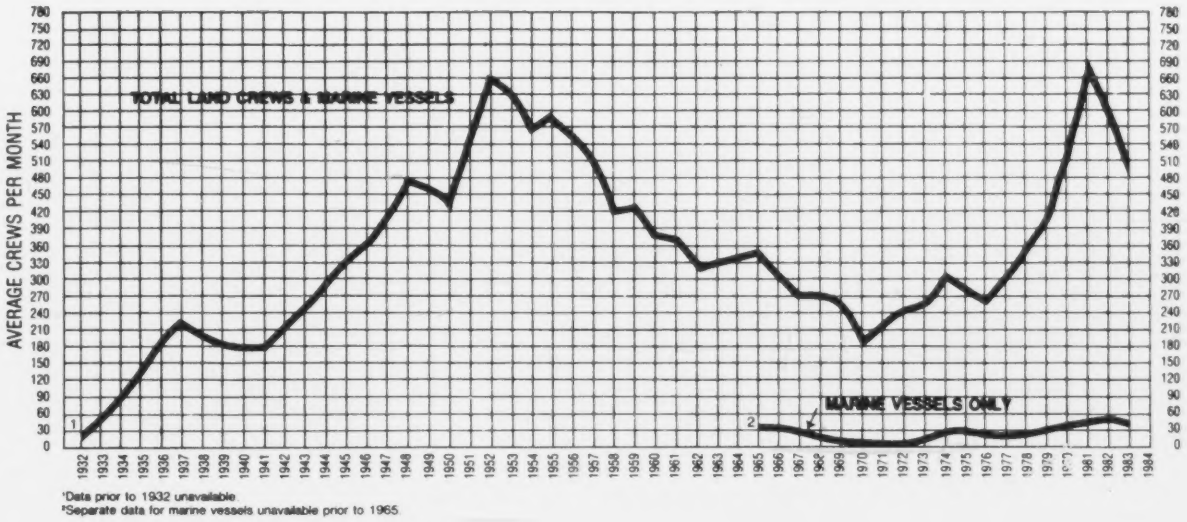
*Total includes government and university activity.

Summary

The year 1983 saw a dominant decline in expenditures reported for the petroleum area worldwide; however, several geographic areas actually enjoyed increases in the number of miles of seismic collected over 1982. They include Mexico, Canada, and the Far East.

Activity in mining and engineering increased as well. The areas that showed greatest increases in mining exploration were Africa, Canada, and the Far East. The Middle East and the United States had the greatest increases in expenditures reported for engineering.

In general, the response to our survey has improved from year to year. This year an effort was made to contact by telephone all the companies and contractors who did not respond to the questionnaires by February. By March we had received data from nearly 70 percent of those outstanding contributors. Further attempts are being made to encourage even more complete reporting. As companies and contractors



[1]Data prior to 1932 unavailable.
[2]Separate data for marine vessels unavailable prior to 1965.

FIG. 5 History of seismic exploration activity in the U.S., 1932-1983. (The total crews working in a given year is not synonymous with the crew-months worked that year.)

become convinced that the confidential and financially sensitive data requested on the questionnaires are being properly safeguarded and protected, we believe that more complete reporting will occur.

Acknowledgments

This report was made possible through the contributions of statistical data by companies, contractors, government agencies, and universities. For many of these organizations, compilation of these data was a long and tedious task. The Geophysical Activity Committee expresses sincere appreciation to all of those individuals who were instrumental in preparing and submitting their activity questionnaires. The committee welcomes comments and suggestions on ways to improve this report.

A special vote of thanks goes to Jerry Henry and Mary Samara of the SEG Business Office who handled the voluminous chores of mailing, receiving, coding, and checking the questionnaires. I would also like to thank Bob Austin and H. T. Konkler for the long hours they have worked with the computer.

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SEGAtlanta

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